NISTTech

Improved Mechanical Support for Two-Pill Adiabatic Demagnetization Refrigerators

Description

Adiabatic Demagnetization Refrigerators (ADRs) permit reaching temperatures below 1 Kelvin (K) by placing a pill, a paramagnetic material, in a high magnetic field, typically the bore of a magnet. Cooling is achieved by first thermally clamping the pill to a thermal ground and by isothermally imposing a large magnetic field on the pill. After the field has been ramped up, the pill is disconnected from the thermal ground. When the field is then reduced, the pill cools. The temperature reached by the pill depends on its magnetic susceptibility and total heat capacity. The total energy available for cooling by the pill is proportional to the susceptibility, the total heat capacity, and the mass of the pill. This technology provides an improved mechanical support for a two-pill (ADR). The two pills are suspended from only one side of the magnet bore providing strong and stiff support. Elimination of the commonly used thermally conductive cylinder support greatly reduces the danger of refrigerator failure due to accidental mechanical thermal contact. This new alignment of the two-pill assembly only needs to be concerned with the base pill to magnet bore spacing, which at the same time eases the constraints on the rigidity of the support. The elimination of the thermally conductive cylinder greatly reduces the danger of refrigerator failure due to accidental mechanical thermal contact. The alignment of the two-pill assembly only needs to be concerned with the base pill to magnet bore spacing, which at the same time eases the constraints on the rigidity of the support. From a practical point of view, the entire pill support can be assembled and aligned first, outside the magnet on a bench, and then installed in the magnet bore. Different pill assemblies could be used interchangeably in one magnet, or the magnet can be removed and checked without having to disassemble and realign the entire two-pill assembly. This invention could be used in applications where cooling, heating or power generation are needed. Refrigeration systems composed of pumps, electric motors, secondary fluids, heat exchangers of different types, magnets and magnetic materials are greatly affected by irreversibilities. Appliances using this method could have a smaller environmental impact if the method is perfected and replaces hydrofluorocarbon (HFCs) refrigerators.

Abstract

This invention provides a mechanical support for a two-pill Adiabatic Demagnetization Refrigerator (ADR). The support utilizes a suspension of the two pills from one side of the magnet bore only. In the two pill ADR, the thermal ground is at 4K, a guard pill positioned in the front of the bore cools to 1K and a base pill positioned in the back of the bore cools to 50-100 mk. A connector rod of the base pill traverses the guard pill, and connector rods to both the guard pill and base pill exit through the front aperture. A preferred embodiment of the two-pill support for the front loaded magnet bore utilizes planar support modules comprising three members connected by Kevlar strings. Each member is thermally connected either to one of the pills or to thermal ground. The ground member, the guard member and the base member of the support module are strung with Kevlar threads, such

that the base member is suspended only from the guard member, and the guard member only from the ground member. These planar support modules can be aligned and assembled prior to use in an assembly jig. The final assembly of the two-pill support structure using planar support modules is easy and fast.

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References

- U.S. Patent # 5,934,077
- Docket: 96-035US

Status of Availability

This invention is available for non-exclusive licensing. NIST has granted a non-exclusive license to this patent.

Last Modified: 02/11/2011